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THE APPLICATION OF ML-SD 15 VIBRATION DAMPING MATERIAL TO TWO A--ETC(U)

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LEVEL II

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REPORT

of

⑥ THE APPLICATION OF MIL-SD 15 VIBRATION DAMPING MATERIAL TO TWO AN/SQS-23 SONAR DOMES.

⑯ F01313 ⑰ SF 013-13-01, Task 0908
10 SEP 1963
Lab. Project 9300-16, Technical Memorandum 2

⑪ 10 Sep 63 ⑨ memo.

⑭ NASL-9300-16-TM-2 ⑫ 16p.

MATERIAL SCIENCES DIVISION

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Lab. Project 9300-16
Tech. Memo No. 2

Ref: (a) BUSHIPS ltr F 013-13-01, Ser 634C1 - 441 of 9 May 1962
(b) MATLAB NAVSHIPYDNYK Project 6062, Progress Report 37 of 26 Jan 1962
(c) MATLAB NAVSHIPYDNYK Project 6062, Progress Report 38 of 26 Jul 1962
(d) Visit of Messrs. A.W. Cizek, Jr. (Code 9370) and R.R. Winans (Code 9360), MATLAB to BUSHIPS (Codes 634C1 and 689C) on 18 May 1961
(e) MIL Spec MIL-P-22581A (SHIPS) Amnd 2, dated 12 Jun 1962
(f) MATLAB NAVSHIPYDNYK, Project 6062, Progress Report 33 of 9 Aug 1961
(g) Visit of Mr. A.W. Cizek, Jr., MATLAB (Code 9370) to BUSHIPS (Codes 634C1 and 689C) on 18 Dec 1962
(h) Visit of Mr. E. Bukzin, BUSHIPS (Code 342A) to MATLAB on 10 and 11 Jan 1963
(i) Fonecon between Mr. J. Rigdon, BUSHIPS (Code 689C) and Mr. A.W. Cizek, Jr., MATLAB (Code 9370), on 11 Jan 1963
(j) BUSHIPS ltr F013-13-01, Ser 634C1-1129 of 25 Jan 1963
(k) NAVSHIPYDNYK ltr 9190 of 23 Jan 1963

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1. INTRODUCTION

a. The development program on sonar dome damping, authorized in reference (a), is continuing at the Applied Science Laboratory.

b. This report deals specifically with the application of ML-SD15, a sprayable viscoelastic formulation developed at the Laboratory, to the interiors of two 360 inch sonar domes, in lieu of the conventional sand-foam vibration damping system presently used.

2. BACKGROUND

a. Sand-foam damping systems for domes: Although instrumentation for sonar detection has progressed to a fairly advanced stage, the presence of interference noises still remains the fundamental controlling factor in establishing sonar range and accuracy. Some of the interference noise is transmitted to the sonar transducers as a result of vibrations due to hydrodynamic or structure-borne excitations in the hull-mounted sonar dome itself. One of the methods currently used to reduce the vibrations in the AN/SQS-23 sonar dome is to fill the lower section, below the acoustic "window", with approximately 5-6 inches of Ottowa sand and to blanket this sand with foamed-in-place, high density polyurethane foam.

b. Deficiencies in sand-foam damping system: In reference (d), Bureau of Ships and Laboratory representatives discussed the deficiencies inherent in the sand-foam system. Field reports had indicated that the foam blanket loosened and permitted water to penetrate the sand. This water penetration, coupled with movement of the sand, resulted in both corrosion and erosion degradation of the dome, and decreased damping efficiency. It was concluded that greater damping of the sonar dome, without the resultant corrosive condition, might be accomplished by substituting a viscoelastic material.

c. Poured ML-D2 damping system for domes: In reference (b), the Laboratory, reported that 160 lbs of ML-D2 material(reference (e)),poured into the bottoms of a 100 inch sonar dome, produced damping essentially equivalent to that obtained with 300 lbs. of sand and foam, and, furthermore, that neither the ML-D2 material nor the primer applied to the hull was affected in any way by immersion in 4% salt water solution.

d. Sprayable MIL-DS15 damping system for domes:

(1) Reference (c) reported the development of a vibration damping spray system consisting of the following:

(a) A high aggregate, non-sag, viscoelastic formulation, designated as ML-SD15, which could be sprayed on vertical and overhead surfaces. The formulation of this material is presented in enclosure (1).

(b) Equipment for spraying this material at relatively low pressures.

(2) Test results indicated that the vibration damping characteristics of the ML-SD15 formulation (4.5 lb/sq ft at a nominal thickness of 1/2"), as determined by the Disc Method, reference (e), were somewhat better than the conventional ML-D2 material over the frequency range from 1600 cps to 9000 cps (enclosure (2)), and superior to a 6" sand-foam system (approximately 49 lb/sq ft) over the frequency range from 3,000 cps to 11,000 cps (reference (f)).

(3) In view of the above developments, it was recommended that the Bureau authorize the Laboratory to spray the ML-SD15 formulation on the bottom and non-window vertical surfaces of a 360 inch sonar dome of one of the vessels scheduled for conversion under the FRAM program at the New York Naval Shipyard, for the purpose of establishing a technique of application in a large dome, and to determine the performance of the ML-SD15 -sprayed dome, under ship service conditions.

3. <u>APPLICATION OF ML-SD15 FORMULATION TO SONAR DOMES</u>

a. <u>Bureau authorization:</u> On the basis of the recommendation in reference (c), and discussions held on the occasions of references (g), (h) and (i), the Bureau, in reference (j), authorized the application of ML-SD15 to the AN/SQS-23, 360 inch sonar domes of the USS RICH (DD-820) and the USS MAC KENZIE (DD-836) - both scheduled for FRAM conversions at the New York Naval Shipyard.

b. <u>Procurement source:</u> As specified in paragraph 6 of reference (j), the Shipyard purchased 2,000 pounds of ML-SD15 material from Philadelphia Resins Company, Incorporated, 7637 Queen Street, Philadelphia 18, Pennsylvania, on a proprietary basis.

c. <u>Packaging of ML-SD15 formulation:</u> The ML-SD15 material was procured as an approximately 48.5 pound, 3 part system packaged in a single 6 gallon container (Figure 1 of enclosure (3)) and consisted of the following ingredients:

(1) Part 1 consisted of a mixture of 31 pounds of material in a 6 gallon can as follows (Figure 2 of enclosure (3)).

(a) 30 pounds of No. 57 Pattinos sand (90 percent - 80 mesh)

(b) 1 pound of Antimony Trioxide

(2) Part 2 consisted of a mixture of 15.5 pounds of material in a 2 gallon can as follows: (Figure 2 of enclosure (3))

(a) 3.3 pounds of Halowax 4004

(b) 8.0 pocunds of Versamid 115

(c) 2.3 pounds of Flow Whiz No. LAIS

(d) 0.4 pounds of DMP -30

(e) 1.0 pounds of CAB-O-SIL

(f) 0.04 ounces of pigment (black).

(g) 7 ounces of Xylene

(3) Part 3 consisted of a mixture of about 2.2 pounds of material in a 1 quart can as follows (Figure 2 of enclosure (3))

(a) 1.5 pounds of Epon 828

(b) 9.5 ounces of Xylene

(c) 0.16 ounces of pigment (white)

<u>NOTE:</u> The Parts 2 and 3 containers were embedded in the sand-antimony trioxide mixture of the Part 1 (6 gallon container) for shipping purposes. (Figure 1) of enclosure (3)).

d. <u>Mixing procedures:</u> Mixing of the various components of the ML-SD15 formulation was effected in the following manner:

(1) The Part 2 component of the formulation, in the 2 gallon can, was judiciously pre-heated to approximately 90°F on steam pipes and/or heat lamps. It is important to note that Part 2 contains 8 pounds of a highly viscous polyamide polymer which is extremely difficult to mix at temperatures below 90°F.

(2) After pre-heating, the contents of the Part 2 component were transferred to an air-powered mixer available at the Shipyard (Figure 3 of enclosure (3)) and mixed for approximately 5 minutes to further decrease the viscosity and to insure homogeneity of the mixture.

(3) The contents of the Part 3 component were then added to the mixer and blended for an additional 5 minutes.

(4) One quart of Xylene was added to the above mixture to assure ease of flow through the rubber spray hoses and blending continued for an additional 10 minutes.

(5) The contents of the Part 1 component were then added to the mixture in three equal increments in order to insure complete and thorough wetting of the filler

(6) Following the addition of the last ingredient, mixing was continued for approximately 20 minutes to insure thorough blending.

e. Application procedures:

(1) Equipment: The following spray equipment, available at the Shipyard (Shop 71), was found to be satisfactory for spraying ML-SD15 (Figure 4 of enclosure (3)).

(a) A 5 gallon Binks bottom outlet spray tank, fitted with a 32 pound follower plate.

(b) A 10 foot length of Goodyear sandblasting hose (1 1/4" ID - 2" O.D).

(c) A DeVilbiss vermiculite spray gun with 1/4" air nozzle.

(2) Masking: Dome structural members, comprising the "acoustic "window" areas, and baffles were masked prior to spraying in order to prevent spattering and overspraying. (Figures 1 and 2 of enclosure (4)).

(3) Pressures employed: After the ingredients were mixed as outlined in paragraph 3 d above, the entire contents were poured into the spray tank, the follower plate was inserted on top of the material, and the following pressures applied:

(a) Full line pressure (90 - 100 psi) on the material.

(b) Atomizing pressure adjusted to a fine spray (approximately 50 psi)

(4) Spraying of domes: ML-SD15 was sprayed to the interiors of the two 360 inch sonar domes as follows:

(a) USS RICH (DD 820): Material was applied to the bottom of the dome to replace the area currently being damped with the standard sand-foam installation. In addition, the ML-SD15 formulation was sprayed along the sides of the "non-window" areas in line with the bottom of the transducer (Figure 3 of enclosure (4)).

(b) USS MAC KENZIE (DD 836): All practicable "non-window" areas were covered, including the bottom of the dome, a 7 1/2" wide strip below the flange around the periphery of the entire dome, and a 12" wide strip on each side of the dome at the after sonar baffle (Figure 4 of enclosure (4)).

(c) The ML-SD15 formulation was sprayed to a nominal thickness of 1/2" (approximately 4.5 lb/sq ft), over sound painted surfaces consisting of Formula 117 pre-treatment primer, 119 anti-corrosive paint, and 121 anti-fouling paint (Figure 1 of enclosure (5)). A metal probe was used to determine the thickness of the coating. In the case of the vertical surfaces, it was necessary to spray multiple coats of ML-SD15 to obviate the possibility of sagging (Figure 2 of enclosure (5)).

Note: One unit of material (approximately 48.5 pounds) covered 14-15 sq. ft of area at 1/4" thickness.

(5) Precautionary Measures: It is important to note that the curing characteristics of any epoxy-polyamide system such as ML-SD15, are dependent on the prevailing temperature and humidity conditions. Therefore, it was necessary to employ the following procedures:

(a) All spray applications were conducted indoors, with a temperature of approximately 70° F being maintained at all times (Figure 3 of enclosure (5)).

(b) All materials were stored indoors at approximately 70° F

(c) No material was mixed unless it could be scheduled for application during the course of a single work shift.

(6) Care of equipment: Cleaning of equipment was affected in the following manner:

(a) The mixing container, spray tanks, guns, etc., were first cleaned with a solvent, such as xylene, and followed by a soap and boiling water washdown.

(b) Hoses were cleaned under pressure by first blowing xylene through, followed by soap and boiling water.

(7) Recommended practices to be employed in spraying ML-SD15: Based on the experiences gained in spraying the two 360 inch sonar domes, with the ML-SD15 material as described above, it is recommended that the following application procedures be employed.

(a) The temperature of the Part 2 component is to be maintained at 90°F for at least one hour prior to mixing - in order to decrease its viscosity and improve mixing characteristics.

(b) A slow speed, heavy duty, double planetary mixer, similar to the Ross Mixer which is available in the Laboratory (Figure 4 of enclosure (5)), is recommended for future applications. A mixer of this type offers better blending characteristics and reduces mixing time.

(c) It has been found that some of the components of the formulation may collect on the sides of the mixing container. Should this occur, it is important to scrape the material off the sides and blend into the mixture.

(d) At least 3 or 4 coats are to be applied in order to obtain the required material thickness on vertical surfaces. In addition, it is necessary that each separate coat be cured for at least one day prior to the application of the next coat.

(e) In the event that indoor application is not feasible, it is suggested that suitable coverage be constructed around the dome so that the required temperature can be maintained.

(f) Approximately one hour, just prior to the end of a work shift, should be allotted for cleaning purposes.

4. COST ANALYSIS: A comparative cost analysis for installing the standard-foam system and the sprayable ML-SD15 material in 360 inch domes is presented below. In addition, a comparison is made between the estimated (reference (k)) and actual costs of installing the ML-SD15 formulation.

a. Sonar dome damped with standard sand-foam system (bottom only)

Material cost

4500 lbs Ottowa sand at $5.00/100 lbs	$225
450 lbs Lockfoam Part A-CA620T at $2.00/lb	900
225 lbs Lockfoam Part B-CA620R at $2.00/lb	450
Total material cost	$1,575

Labor cost

8 man - days at $33/day	$264
8 man - days (overhead) at $21/day	168
Total labor cost	$432
Total Costs	$2,007

b. Sonar dome damped with ML-SD15 formulation (material applied to bottom of dome and along sides of the "non-window" areas in line with the bottom of the transducers)

Material cost

ML-SD15 material at $0.33/lb plus cost of solvents and miscellaneous material for cleaning equipment:

Estimated lbs	Estimated Cost	Actual lb.	Actual cost
915	$350	920	$325

Labor cost

	Estimated days	Estimated cost	Actual days	Actual cost
Man - days at $33/day	10	$330	12	$396
Man - days (overhead) at $21/day	10	$210	12	$252
Total Labor Cost		$540		$648
Total Costs		$890		$973

c. Sonar dome damped with ML-SD15 formulation (material applied to all practicable "non-window" areas, including bottom as described in paragraph b. above, a 7 1/2" wide strip below the flange around the periphery of the entire dome and a 12" wide strip on each side of the dome at the after sonar baffle)

Material cost

ML-SD15 material at $0.33/lb plus cost of solvents and miscellaneous material for cleaning equipment.

	Estimated		Actual	
	lb	cost	lb	cost
	1035	$400	1070	$385

Labor Cost	Estimated		Actual	
	days	cost	days	cost
Man - days at $33/day	11	$363	14	$462
Man - days (overhead) at $21/day	11	$231	14	$294
Total labor cost		$594		$756
Total Cost		$994		$1141

d. A comparison of the cost of installation of the ML-SD15 formulation versus the sand-foam system indicates a saving of $1,034 in the case of one dome, and $866 in the case of the second dome, when using the sprayable ML-SD15 material.

e. Besides the cost advantage, it is also important to note that the additional material coverage, resulting from the ability to spray the ML-SD15 formulation on vertical surfaces, will result in improved vibration damping characteristics in ships' domes.

5. CONCLUSIONS

The ML-SD15 vibration damping formulation, a development of the Applied Science Laboratory, was successfully sprayed on to the bottoms and "non-window" vertical surfaces of the interiors of two 360 inch sonar domes. On the basis of the experiences of the Laboratory with the vibration damping characteristics of viscoelastic materials, it is expected that the following advantages will be obtained by the application of the sprayable ML-SD15 material in lieu of the conventional sand-foam system:

a. Improved damping effectiveness- Improvement in sonar efficiency because of superior vibration damping characteristics of the ML-SD15 formulation, particularly over the frequency range from 3,000 cps to 11,000 cps, and because of the additional coverage achieved.

b. Lower cost - Substantial cost savings in application (approximately $1,000 per dome) and maintenance.

c. Improved water resistance.- Resistant to prolonged water immersions, thereby eliminating corrosive degradation in sprayed areas.

d. Improved application procedures. - Ease of application over curved surfaces, in corners, and between closely spaced structural members.

e. Flame Retardant - Self-extinguishing characteristics in accordance with ASTM method D-635.

f. Improved adhesion.- Excellent adhesion to primed or unprimed steel surfaces subject to shock and heavy vibrations.

g. Lower weight. - Substantial reduction in the overall weight of the damped dome.

6. FUTURE WORK

Future work in this program, directed towards reducing sonar self-noise in the ASW program to increase sonar capability, will include:

a. Further development of the ML-SD15 formulation and spray equipment to achieve greater cost savings and improved application procedures.

b. Investigation of the feasibility of using the sprayable ML-SD15 formulation in those shipboard applications where other types of vibration reduction materials are presently being installed.

c. Development of acoustically transparent materials in order to completely cover the interior sonar surface without restricting sound transmission.

d. Determination of the characteristics of the ML-SD15 formulation under conditions of deep submergence for possible application in deep-diving submarines.

e. Participation in sea trials of both the USS RICH and the USS MAC KENZIE (October or November 1963) in order to determine the damping effectiveness of the ML-SD15 material and also to determine differences in sonar characteristics attributable to differences in the extent of coverage in the two domes, as described in subparagraphs e (4) of paragraph 3.

U.S. Naval Applied Science Laboratory

Lab. Project 9300-16
Tech. Memo. No. 2
Enclosure (1)

Formulation of ML-SD15 Sprayable Vibration Damping Material

Component	Function	Parts By Weight
Epon 828 [1]	Epoxy Co-Reactant	20
Versamid 115 [2]	Polyamide Co-Reactant	100
DMP - 30 [3]	Polyamine Hardener	5
Halowax 4004 [4]	Chlorinated Paraffin Flame Retardant	42
Antimony Trioxide [5] (Technical Grade-Powder Form)	Flame Retardant	14
Sand [6] (#57 Pattinos 90 Percent 80 Mesh)	Filler	400
CAB - O - SIL [7]	Thixotropic Agent	12
Flow Whiz No. LAIS [8]	Anti-Sag Agent	29
Xylene	Solvent	12

Notes:
(1) Shell Chemical Co., New York 20, N.Y.
(2) General Mills Inc., Kankakee, Illinois
(3) Rohm and Haas Co., Special Products Div., Philadelphia, Pa.
(4) Koppers Co., Inc., Tar Products Div., Pittsburg, Pa.
(5) City Chemical Corp., New York, N.Y.
(6) George Pattinos Sand Co., Bala Cynwood, Pa.
(7) Cabot Corp., Boston 10, Mass.
(8) Axel Plastic Research Laboratories, L.I.C., N.Y.

U.S. Naval Applied Science Laboratory

Lab. Project 9300-16
Tech. Memo. 2
Enclosure (2)

Vibration Damping and Stability Characteristics of ML-SD15 Formulation

A. **Vibration Damping Characteristics***
(4.5 lb/sq. ft - nominal 1/2" thickness)

Disc Diameter (Inches)	ML-SD15 Sprayed on to 3/8" Steel Discs Frequency (~/sec)	Effective Decay Rate (db/sec)	Percent Critical Damping (% c/cc)
8	1,600	5,900	6.8
6	3,000	15,900	9.7
4	6,500	24,000	7.0
3 1/2	8,250	25,500	5.7
3	10,750	19,000	3.2

*Disc Method

B. **Stability Characteristics**

1. Flame retardant
2. Resistant to salt water immersion
3. Resistant to jet fuel (JP-5) immersion
4. Good adhesion to primed and unprimed surfaces

U.S. Naval Applied Science Laboratory

Lab. Project 9300-16
Technical Memorandum 2
Enclosure (3)
PHOTO: L19529-1

Figure 1. View Showing 5 Gallon Packaging Container

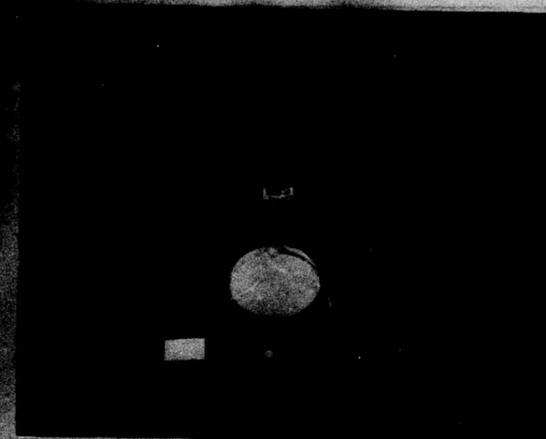

Figure 2. View Showing Packaging of Individual Components

Figure 3. View Showing Air Powered Mixer

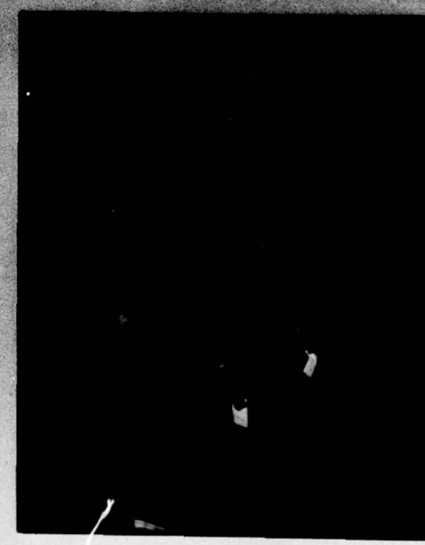

Figure 4. View Showing 5 Gallon Binks Spray Tank, Follower Plate, Hose, and De Vilbiss Gun

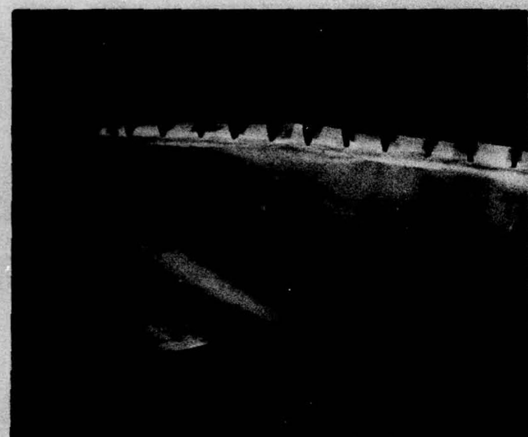

Figure 1. View Showing Masking of Acoustic "Window" Areas

Figure 2. View Showing Masking of Baffle

Figure 3. View Showing Extent of ML-SD15 Coverage on USS RICH

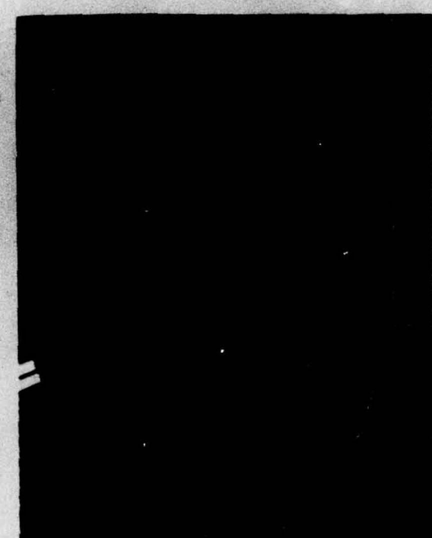

Figure 4. View Showing Bottom and Vertical Surface Coverage with ML-SD15 on USS MAC KENZIE

Figure 1. View Showing Application of ML-SD15 Damping Material

Figure 2. View Showing Partially Completed Application of ML-SD15 to 7 1/2" Area Below Flange in USS MAC KENZIE

Figure 3. View Showing Means of Supporting Dome for Indoor Spray Application

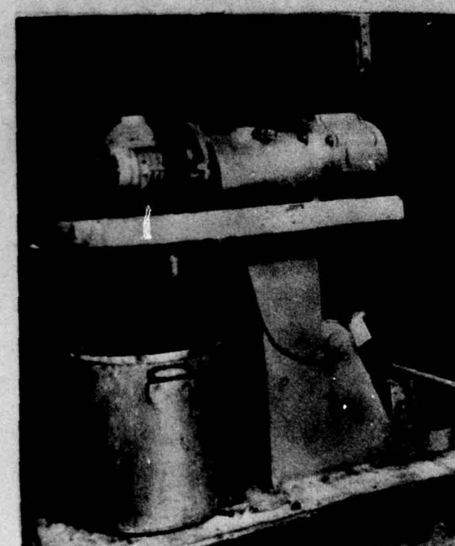

Figure 4. View Showing Slow Speed, Double Planetary Ross Mixer